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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/732,927	12/10/2003	Jorge L. Gardea-Torresdey	UTSE:103US	7368

7590 08/08/2005

FULBRIGHT & JAWORSKI L. L. P.
SUITE 2400
600 CONGRESS AVENUE
AUSTIN, TX 78701-3271

EXAMINER	
FORD, ALLISON M	
ART UNIT	PAPER NUMBER
1651	

DATE MAILED: 08/08/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 10/732,927	Applicant(s) GARDEA-TORRESDEY ET AL.	
	Examiner Allison M. Ford	**Art Unit** 1651	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *15 July 2005*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-23* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-23* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *17 September 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

JC

DETAILED ACTION

Response to Arguments/Amendments

Applicant's arguments filed 15 July 2005 have been fully considered but they are not persuasive. Amendments to claims 1, 6, 11, 14, 17-19 and 21-23 have been entered. Claims 1-23 remain pending in the current application. The declaration under 37 CFR 1.132 filed 15 July 2005 is insufficient to overcome the rejection of claims 1, 2, 5-20 & 22 based upon Gardea-Torresdey *et al* (Nano Letters, Jan. 30, 2002) as set forth in the last Office action because: the declaration is not signed, therefore it is ineffective and inadmissible.

Priority

Acknowledgement is made of applicant's claim for priority to provisional application 60/432,160, filed 12/10/2002.

Information Disclosure Statement

The listing of references in the specification is not a proper information disclosure statement. 37 CFR 1.98(b) requires a list of all patents, publications, or other information submitted for consideration by the Office, and MPEP § 609 A(1) states, "the list may not be incorporated into the specification but must be submitted in a separate paper." Therefore, unless the references have otherwise been cited by the examiner on form PTO-892, only the references actually cited on the IDS, filed 3/22/04 have been considered.

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 1, 5 and 6 stand rejected under 35 U.S.C. 112, first paragraph, because the specification, while being enabling for alfalfa, does not reasonably provide enablement for any plant, any dicot or even any dicot of the phylum Magnoliophyta. The specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to use the invention commensurate in scope with these claims.

While applicant does provide a representative number of species of plants and a representative number of dicots, their examples of successfully producing the precious metal nanoparticles, as well as the examples provided in the references, are limited to use of alfalfa. Alfalfa has demonstrated an inherent ability to tolerate growth in environments with high concentrations of heavy metals, a unique property, as high heavy metal concentrations are lethal to many plants (See Gardea-Torresdey et al, *J of Hazardous Materials*, 1999, pg 42 & Gardea-Torresdey et al, *Nano Letters*, 2002, pg 397, col. 2); however there is no disclosure or explanation of this inherent ability to thrive in the high metal concentration environments, or any disclosure or explanation of the alfalfa's ability to produce metal nanoparticles. Therefore, while applicant has enabled for success with the use of alfalfa, they have not provided evidence of similar success with a sufficient number of representative species which is required to claim all Magnoliophytas, all dicots, or all plants.

Applicants argue that the inventors were, in fact, enabled for use with all plants at the time the invention was made, citing works by Gardea-Torresdey *et al* (Bioresource Technology, 2004) and Gardea-Torresday *et al* (Analytical and Bioanalytical Chemistry, 2005). This is not found persuasive because neither of these references have been provided, and thus they have not been considered. However, it appears the articles describe *Convolvulus arvensis L* and *Chilopsis linearis* as examples, it is

noted that both these plants are dicots and of the phylum Magnoliophyta; therefore applicant has still failed to provide a sufficient number of representative species of non-Magnoliophytas and non-dicots, which is required to claim all plants. Additionally, it is noted that, by applicant's own admission, it is not clear if all plants are capable of producing metal nanoparticles; applicants particularly doubt that creosote bushes (*Larrea tridentata*) (which are both a dicot and a Magnoliophyta) produce nanoparticles (See response, page 8). Therefore, by applicant's own submission it would require excessively undue experimentation to determine which plants would or would not be able to produce nanoparticles, because applicants do not believe creosote bushes are capable of doing so.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 1-23 stand rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Applicant's claim 1 is directed to a method of producing a precious metal nanoparticle, comprising (a) selecting a plant growth environment comprising a precious metal source; (b) growing a plant in said plant environment; and (c) isolating said precious metal nanoparticle. It is not clear if the method is intended to produce the precious metal nanoparticle in the plant growth environment, in the plant, or if the method is intended to isolate the precious metal nanoparticle from the plant, as suggested in step (c). Claims 2-23 have the limitation of claim 1 and thus are rejected on the same basis.

Applicant's claim 1 remains unclear, despite the amendment. The preamble of claim 1 still fails to properly correlate with the body of the claim; therefore it is not clear what the method is intended to accomplish.

Applicant's claim 8 is directed to the method of claim 1, wherein isolating comprises isolating a part of said plant. Claim 9 requires the plant part to be a leaf, a stem, or a root. As is, applicant's claim is so broad as to read on simply picking a leaf or stem from a plant grown in the appropriate environment; it is not clear if this is applicant's intent or if further isolation steps are required. Claims 9-14 have the limitation of claim 8, and thus are rejected on the same basis.

Applicants argue that it is abundantly clear that the materials being obtained from the plant in claims 8-14 are to be used subject to the isolation step of claim 1 because claim 1(c) requires isolating the precious metal nanoparticles. This is not found persuasive because, by applicant's own admission, an isolation step can comprise isolating a part of a plant, see claim 8 "A method of producing a precious metal nanoparticle in a plant comprising (a) selecting a plant growth environment comprising a precious metal source; (b) growing a plant in said plant environment; and (c) isolating said precious metal nanoparticle, wherein isolating comprises isolating a part of said plant." Therefore, because applicant's claim 8 teaches that the isolation step of claim 1 step (c) can comprise isolating part of a plant, it is so broad so as to read on picking a leaf, and thus, it remains unclear if a further isolation step is required; the claims have been interpreted so that picking a leaf satisfies the requirement of isolating precious metal nanoparticles.

Applicant's claim 21 is directed to the method of claim 16, and requires creating said plant growth environment comprises: (i) selecting a desired particle size; and (ii) adjusting the precious metal concentration to produce said desired particle size. It is not clear if "particle size" is referring to the nanoparticles of precious metal referenced in claim 1, or other components of soil. If the precious metal nanoparticles are being referenced, the term "precious metal nanoparticles" should be used consistently throughout the application. Additionally, it is not clear how the precious metal concentration produces particles of a desired size, whatever the particles may be. Applicant has provided no information or

description on how the concentration of metal correlates to the size of the nanoparticles. Gardea-Torresdey et al (*J. of Nanoparticle Research*, 1999) teaches that the shape of the nanoparticles cause variations in size, but they do not provide any teachings, that could be incorporated by reference, on the concentration having any correlation to the size.

Applicant's claim 21 remains unclear for the reasons of record. The amendments merely overcame grammatical errors, but did not address the claims lack of clarity or inconsistency in the terminology.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
> (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1, 2, 5-9, 15-20 & 22 stand rejected under 35 U.S.C. 102(a) as being anticipated by Gardea-Torresdey et al (*Nano Letters*, Jan. 30, 2002).

Gardea-Torresdey et al teach a method of producing a precious metal nanoparticle from plants, comprising creating a plant growth environment comprising gold(III) in agar; planting alfalfa seeds in the agar; allowing the plants to grow; harvesting the alfalfa roots and shoots part of the plant (which applicant calls isolating the precious metal nanoparticles); and identifying gold in the sample (See pg. 398) (Claims 1, 2, 5-9 & 15-20). Gardea-Torresdey et al teach the some gold nanoparticles produced in the plants have an icosahedron (crystalline) structure with an approximate size of 4 nm, other nanoparticles were identified with a fcc twinned structure and an approximate size of 6-10 nm (See Pg 401) (Claim 22). Therefore the reference anticipates the claimed subject matter.

Applicant's argue that this rejection is improper because the reference is not "by another" as required under 35 U.S.C. 102(a). Applicants have submitted a declaration evidencing this fact; however, the declaration is not found persuasive because it is unsigned and thus is not permissible.

Claims 1, 5, 8-10, 12 & 15 stand rejected under 35 U.S.C. 102(b) as being anticipated by Gardea-Torresdey et al (US Patent 5,927,005), in light of USDA "Plants Profile."

Gardea-Torresdey et al teach a method of recovering heavy metals from contaminated soils comprising selecting a plant growth environment comprising a heavy metal source, growing a plant in the plant growth environment, and isolating heavy metal nanoparticles (col. 2, ln 39-64) (Claim 1). Gardea-Torresdey et al define "heavy metals" as any metal having a molecular weight greater than sodium (MW= 22.99g/mol) (See col. 1, ln 22-24), therefore including precious metals such as gold (MW=197.0 g/mol), silver (MW=107.9 g/mol), and platinum (MW=195.1). Gardea-Torresdey et al use creosote bushes (*Larrea tridentata),* a dicot, to absorb the heavy metals from contaminated ground (See col. 1, ln 10-15 & USDA "Plants Profile"). The plants can grow naturally in the contaminated environment, or they can be grown by planting a seed, a sprout, or a grown plant (See col. 3, ln 33-46) (Claim 15). The heavy metals are isolated by removing a leaf, stem, or root of the plant (Claims 8-9). The metals are then extracted from the leaves by chemically disrupting the plant by treating the plant with acid or other metal chelators (See col. 3, ln 5-33) (Claims 10 & 12). The slurry is then subjected to isolation procedures (See col. 6, ln 5-58). Therefore the reference anticipates the claimed subject matter.

Applicants argue that Gardea-Torresdey et al do not teach isolating the precious metal nanoparticles. They further argue that the reference uses creosote bushes, and it is unclear if these bushes produce nanoparticles. This is not found persuasive because, as stated above, the method of Gardea-Torresdey et al does involve isolating heavy metal nanoparticles (See col. 2, ln 39-64 & col. 1, ln 22-24).

Additionally, applicant's arguments are unclear with regards to what limitations they do not feel are anticipated, and why.

Claims 1-3, 5, 8, 9 & 15-19 stand rejected under 35 U.S.C. 102(b) as being anticipated by Raskin et al (US Patent 5,785,735).

Raskin et al teach a method of removing metal ions from soil, comprising selecting a plant growth environment comprising a metal source or creating a plant growth environment by adding metal ions to a soil pot; growing plant in said plant growth environment by transplanting sprouts; and isolating the metal particles by harvesting the roots and shoots (leaves and stem) of the plants and measuring the metal content (See col. 9, ln 55- col. 10, ln 45 & Table 1) (Claims 1, 8-9 & 15-19). Raskin et al used plants from the family *Brassicaceae*, for example, *Brassica juncea*, a dicot (See col. 10, ln 48-60) (Claim 5). Raskin et al teach this method can be used to remove a variety of metals, including gold and silver (See col. 5, ln 12-20) (Claims 2 and 3). Therefore the reference anticipates the claimed subject matter.

Applicant argues that Raskin et al do not teach the limitation of claim 1(c) isolating the precious metal nanoparticles. However, this is not found persuasive because, by applicant's own admission in claim 8, isolating a part of a plant satisfies the limitation "isolating said precious metal nanoparticle;" therefore, because Raskin et al teach harvesting (isolating) roots and shoots, they are effectively isolating precious metal nanoparticles.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 10-14 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Gardea-Torresdey et al (*Nano Letters*, Jan. 30, 2002).

Gardea-Torresdey et al teach a method of producing a precious metal nanoparticle from plants, comprising creating a plant growth environment comprising gold(III) in agar; planting alfalfa seeds in the agar; allowing the plants to grow; harvesting the alfalfa roots and shoots part of the plant (which applicant calls isolating the precious metal nanoparticles); and identifying gold in the sample (See pg. 398). Gardea-Torresdey et al teach the some gold nanoparticles produced in the plants have an icosahedron (crystalline) structure with an approximate size of 4 nm, other nanoparticles were identified with a fcc twinned structure and an approximate size of 6-10 nm (See Pg 401).

Though Gardea-Torresdey et al do not teach disrupting the plant part before analysis of the gold contents, it would have been obvious to one of ordinary skill in the art at the time the invention was made to first disrupt the harvested plant part by physical, chemical, or biological methods (Claim 10). One of ordinary skill in the art would have been motivated to first disrupt the harvested plant parts to liberate the contents of the plant for purposes of analysis. Such physical means of disruption could include pressing, grinding, sonicating, extraction or burning (Claim 11). Such chemical means include digestion (Claim 12). Such biological means could include enzymatic degradation or microbial degradation (Claim 13). One would have expected success with any of these means of disruption because they are all commonly known in the art as successful methods of breaking down biological material into a slurry for the purposes of analysis. Additionally, once the plant part is disrupted, it would have been obvious to one of ordinary skill in the art to remove excess cellular debris by means of chromatography, centrifugation or electrophoresis (Claim 14). The skilled artisan would have been motivated to perform chromatography, centrifugation or electrophoresis in order to separate large, undigested or non-disrupted pieces of plant material, that were not broken down during disruption to allow for easier analysis of the metal nanoparticles present in the remaining supernatant. One would have expected success because

centrifugation, chromatography and electrophoresis are well known methods in the art for separation and purification of heterogeneous mixtures. Therefore the invention as a whole would have been *prima facie* obvious to one of ordinary skill in the art at the time the invention was made.

Applicants argue that this rejection is improper because the reference is not "by another." Applicants have submitted a declaration evidencing this fact; however, the declaration is not found persuasive because it is unsigned and thus is not permissible.

Claims 2-4 & 10-14 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Gardea-Torresdey et al (US Patent 5,927,005).

Gardea-Torresdey et al teach a method of recovering metals from contaminated soils comprising selecting a plant growth environment comprising a heavy metal source, growing a plant in the plant growth environment, and isolating heavy metal nanoparticles. Gardea-Torresdey et al use creosote bushes (*Larrea tridentata*) to absorb the heavy metals from contaminated ground (See col. 1, ln 10-15). The heavy metals are drawn into the plant and isolated by removing a leaf, stem, or root of the plant; the metals are then extracted from the leaves by chemically disrupting the plant by treating the plant with acid or other metal chelators (See col. 3, ln 5-33). The slurry is then subjected to isolation procedures (See col. 6, ln 5-58). Though Gardea-Torresdey et al teach a variety of chemical reactions that can be used to disrupt the plant parts through digestion by metal chelating agents, it would have also been obvious to one of ordinary skill in the art at the time the invention was made to use any well known method to disrupt the plant material, such as physically grinding, e.g. in a blender, sonicating, or burning the plant parts, or biologically disrupting the plant material with enzymatic or microbial degradation, such as with cellulase (Claims 10-13 One would have expected success with any of these means of disruption because they are all commonly known in the art as successful methods of breaking down biological material into a slurry for the purposes of analysis. Additionally, once the plant part is disrupted, it would have been obvious to

one of ordinary skill in the art to remove excess cellular debris by means of chromatography, centrifugation or electrophoresis (Claim 14). The skilled artisan would have been motivated to perform chromatography, centrifugation or electrophoresis in order to separate large, undigested or non-disrupted pieces of plant material, that were not broken down during disruption to allow for easier analysis of the metal nanoparticles present in the remaining supernatant. One would have expected success because centrifugation, chromatography and electrophoresis are well known methods in the art for separation and purification of heterogeneous mixtures.

Additionally, though Gardea-Torresdey et al do not specifically teach isolating gold, silver, or platinum, it would have been obvious to one of ordinary skill in the art at the time the invention was made to utilize this method to isolate any heavy metal from contaminated soil. One of ordinary skill in the art would have been motivated to remove gold, silver or platinum from contaminated soil in order to isolate these precious metals for their monetary worth as well as their usefulness in the nanotechnology field. One would have expected success because Gardea-Torresdey et al define "heavy metals" as any metal having a molecular weight greater than sodium (MW= 22.99g/mol) (See col. 1, ln 22-24), therefore precious metals such as gold (MW=197.0 g/mol), silver (MW=107.9 g/mol), and platinum (MW=195.1) would also be expected to be isolated by this method. Therefore the invention as a whole would have been *prima facie* obvious to one of ordinary skill in the art at the time the invention was made.

Applicants argue that Gardea-Torresdey et al do not teach isolating the precious metal nanoparticles. They further argue that the reference uses creosote bushes, and the ability of creosote bushes to produce nanoparticles is unpredictable, therefore there is no expectation of success. This is not found persuasive because, as stated above, the method of Gardea-Torresdey et al does involve isolating heavy metal nanoparticles (See col. 2, ln 39-64 & col. 1, ln 22-24). Furthermore, applicant's arguments are unclear with regards to what limitations they do not feel are anticipated and why.

With regards to the unpredictability of creosote's ability to produce nanoparticles, it is unclear what evidence applicant is basing their assertion on; still further, this seems to be in direct contrast with applicants earlier assertion that all plants are capable of producing nanoparticles (See response, pg. 6, paragraph 1). Therefore, this is found unpersuasive because applicant's have failed to provide evidence why use of creosotes are not enabled, rather, by applicant's own earlier admission, all plants are enabled; therefore this argument appears unsubstantiated.

Claims 10-14 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Raskin et al (US Patent 5,785,735).

Raskin et al teach a method of removing metal ions from soil, comprising selecting a plant growth environment comprising a metal source or creating a plant growth environment by adding metal ions to a soil pot; growing plant in said plant growth environment by transplanting sprouts; and isolating the metal particles by harvesting the roots and shoots (leaves and stem) of the plants and measuring the metal content (See col. 9, ln 55- col. 10, ln 45 & Table 1). Raskin et al used plants from the family *Brassicaceae*, for example, *Brassica juncea*, a dicot (See col. 10, ln 48-60) (Claim 5). Raskin et al teach this method can be used to remove a variety of metals, including gold and silver (See col. 5, ln 12-20).

Though Raskin et al teach measuring the metal content of the plants, they do not teach a method of disrupting the plants by physical, chemical or biological methods. However, it would have been obvious to one of ordinary skill in the art at the time the invention was made first disrupt the harvested plant parts by physical, chemical, or biological means to create a slurry, and then to isolate the metal particles by an appropriate method such as centrifugation, chromatography, or electrophoresis (Claims 10-14). One of ordinary skill in the art would have been motivated to isolate the particles by first disrupting the plant parts to liberate the contents of the plant for purposes of analysis. Such physical means of disruption could include pressing, grinding, sonicating, extraction or burning (Claim 11). Such

chemical means include digestion (Claim 12). Such biological means could include enzymatic degradation or microbial degradation (Claim 13). One would have expected success with any of these means of disruption because they are all commonly known in the art as successful methods of breaking down biological material into a slurry for the purposes of analysis. Additionally, once the plant part is disrupted, it would have been obvious to one of ordinary skill in the art to remove excess cellular debris by means of chromatography, centrifugation or electrophoresis (Claim 14). The skilled artisan would have been motivated to perform chromatography, centrifugation or electrophoresis in order to separate large, undigested or non-disrupted pieces of plant material, that were not broken down during disruption to allow for easier analysis of the metal nanoparticles present in the plant slurry. One would have expected success because centrifugation, chromatography and electrophoresis are well known methods in the art for separation and purification of heterogeneous mixtures.

Applicant argues that Raskin et al do not teach the limitation of claim 1(c) isolating the precious metal nanoparticles. However, this is not found persuasive because, by applicant's own admission in claim 8, isolating a part of a plant satisfies the limitation "isolating said precious metal nanoparticle;" therefore, because Raskin et al teach harvesting (isolating) roots and shoots, they are effectively isolating precious metal nanoparticles.

Claims 1-20 & 22-23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gardea-Torresdey et al (*J of Nanoparticle Research*, 1999), in view of Gardea-Torresdey et al (*J of Hazardous Materials*, 1999).

Gardea-Torresdey et al teach a method of producing gold nanoparticles using alfalfa biomass, comprising combining alfalfa biomass with a 0.1 mM gold(III) solution, and then removing the bound gold nanoparticles from the alfalfa biomass by centrifuging the samples, the supernatant solution was then analyzed (See *J of Nanoparticle Research*, pg 399). The gold nanoparticles Gardea-Torresdey et al

observed had a variety of crystalline structures including tetrahedral, icosahedral and other irregular shapes. The decahedral and icosahedral particles showed a twinned structure (See *J of Nanoparticle Research*, Pg 39-400). The icosahedral and irregular shaped particles were the smallest, with diameters of about 15 nm (See *J of Nanoparticle Research*, Fig. 2 & 7 and Pg 400-401). The nanoparticles were zero valence, they were gold(0) (See *J of Nanoparticle Research*, pg 397 & 402) (Claim 22).

Though Gardea-Torresdey et al do not teach growing the alfalfa plants in an environment that comprises a metal source, they do demonstrate the inherent ability of the alfalfa plant to remove and recover precious metal nanoparticles from a gold-containing solution; contact with the alfalfa is all that appears to be necessary for the isolation and extraction of the metal ions from a metal ion-containing solution. Therefore it would have been obvious to one of ordinary skill in the art to isolate precious metal nanoparticles by growing an alfalfa plant in an environment that contains metal ions and then isolating the precious metal nanoparticles from the plant (Claims 1, 2 & 5-7). The environment could be selected due to a naturally high occurrence of metal ions, or the metal ions could be artificially added to the environment; the growth environment can consist of any suitable substrate, including soil, agar, or liquid (Claims 16-20). The alfalfa plants could be grown in any appropriate manner, including planting seeds, planting a sprout, or transplanting an entire plant (Claim 15). One of ordinary skill in the art would have been motivated to select or create a growth environment of soil, agar or liquid in order to isolate the precious metals from other sources for use in nanotechnology applications, as described by Gardea-Torresdey et al. One would expect success growing the alfalfa plants in soil, agar or liquid because these are all suitable growth environments for the plant, and one would have expected success growing the alfalfa plants in the presence of heavy metals because Gardea-Torresdey et al teach that the alfalfa plant is especially tolerant to growing in soil environments contaminated with heavy metals (See *J of Hazardous Materials*, pg 42).

Once the plant had grown in the presence of the metal, due to its inherent ability to remove and recover the metal from its surroundings and produce nanoparticles of the metal, as taught by Gardea-Torresdey et al, it would be obvious to one of ordinary skill in the art to isolate the nanoparticles by appropriate methods, including isolating part of the plant. Gardea-Torresdey et al teach both the roots and shoots are capable of producing the nanoparticles (See pg. 397), disrupting the plant part by physical, chemical, or biological means to create a slurry, and isolating the metal nanoparticles by an appropriate method such as centrifugation, chromatography, or electrophoresis (Claims 8-14). One of ordinary skill in the art would have been motivated to isolate the nanoparticles by first disrupting the plant parts to liberate the contents of the plant for purposes of analysis. Such physical means of disruption could include pressing, grinding, sonicating, extraction or burning (Claim 11). Such chemical means include digestion (Claim 12). Such biological means could include enzymatic degradation or microbial degradation (Claim 13). One would have expected success with any of these means of disruption because they are all commonly known in the art as successful methods of breaking down biological material into a slurry for the purposes of analysis. Additionally, once the plant part is disrupted, it would have been obvious to one of ordinary skill in the art to remove excess cellular debris by means of chromatography, centrifugation or electrophoresis (Claim 14). The skilled artisan would have been motivated to perform chromatography, centrifugation or electrophoresis in order to separate large, undigested or non-disrupted pieces of plant material, that were not broken down during disruption to allow for easier analysis of the metal nanoparticles present in the plant slurry. One would have expected success because centrifugation, chromatography and electrophoresis are well known methods in the art for separation and purification of heterogeneous mixtures.

Finally, though Gardea-Torresdey et al (*J of Nanoparticle Research*) use gold as the only metal in the metal-containing solution, it would have been obvious to one of ordinary skill in the art to extract other metals from an environment that contains other metals, such as silver and platinum. One of

ordinary skill in the art would have been motivated to extract other metals such as silver and platinum for use in nanotechnology. Gardea-Torresdey et al (*J of Nanoparticle Research*) teach that the use of metal nanoparticles for nanoelectronic devices is a developing field (See pg 397); therefore one would be motivated to use nanoparticles that can easily be produced and extracted from the common alfalfa plant. One would expect success producing silver and platinum nanoparticles because Gardea-Torresdey et al (*J of Nanoparticle Research*) teach success with gold, and Gardea-Torresdey et al (*J of Hazardous Materials)* teach similar success extracting other various heavy metals, such as cadmium, chromium, copper, lead, nickel, and zinc. Therefore it appears the alfalfa plant is capable of the same extraction and nanoparticle producing action on all heavy metals, and thus would act similarly on silver and platinum (Claims 3, 34 & 23). Therefore the invention as a whole would have been *prima facie* obvious to one of ordinary skill in the art at the time the invention was made.

Applicants argue that the teachings of the prior art, which shows growth of alfalfa in solution, would not have rendered obvious the growth of plants in a solid plant growth medium because in solid growth medium there is a chance of the metals undergoing reactions to complex them to other agents which may inhibit them from uptake or formation of nanoparticles. Applicants further argue that there is no link between dead plants and living plants when discussing the formation of nanoparticles. In particular, applicants argue that living plants use phytosiderophores to solubilize metals, and then later take the metals up to produce nanoparticles inside the plant. In contrast, dead plants form particles by a passive process occurring when the dead biomass is in contact with the metal-containing liquid medium. Thus applicants assert there was no reason to relate living to dead plants.

These arguments are not found persuasive because while Gardea-Torresdey et al (J. Nanoparticle Res.) teach growing alfalfa in solution and not in solid growth medium, it would have been obvious at the time the invention was made, to alternatively grow the alfalfa in a solid plant growth medium. While applicants have suggested that there is a possibility of interference between the metal

particles and components of soil, they have provided no substantial evidence that this problem would prevent the uptake of metal particles into the plants and thus deter one from trying; therefore, one of ordinary skill in the art, at the time the invention was made, would have at least had a reasonable expectation of successfully performing the procedure of Gardea-Torresdey et al in a solid plant growth environment. One would have found motivation as in the teachings above.

With regards to the comparison of the uptake process in live plants versus dead plants, it is first noted that the information regarding the phytosiderophores produced by live plants was not disclosed at the time the invention was made. In order to make a prima facie case of obviousness one must only consider information that would have been available to one of ordinary skill in the art *at the time the invention was made.* At the time the invention was made it appeared to be an undisclosed property of alfalfa biomass to uptake metal particles and produce nanoparticles; therefore despite the different mechanisms utilized in live versus dead plants, both result in the formation of nanoparticles. Because Gardea-Torresdey et al produced metal nanoparticles by soaking alfalfa biomass in metal particle-containing solution, it would have been well within the purview of one of ordinary skill in the art at the time the invention was made to expect the same nanoparticle production when live or dead plants were soaked in (exposed to) metal particles-containing solution. At the time the invention was made, one of ordinary skill in the art would have had a reasonable expectation of successfully forming nanoparticles by exposing live or dead biomass to metal particle-containing solution because it was an unknown property of the alfalfa biomass to produce nanoparticles upon exposure to metal particle-containing solution. Furthermore, regarding the importance of the recently discovered phytosiderophores on the production of nanoparticles, it is noted that applicants have provided no objective evidence showing the alfalfa of the prior art does not contain phytosiderophores. Phytosiderophores may still be present in recently picked plants (which appear to be what was used in the prior art, it is further noted recently picked plants are still alive) or in completely dead plants; if the biomass is not subjected to an extraction process that removes

these chemical molecules, it would be well within the purview of one of ordinary skill in the art to expect the chemicals to still be present and functional regardless of the life status of the plant. Therefore, the examiner maintains that the presently claimed invention, as a whole, would have been *prima facie* obvious to one of ordinary skill in the art at the time the invention was made.

Conclusion

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Allison M Ford whose telephone number is 571-272-2936. The examiner can normally be reached on M-F 7:30-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Wityshyn can be reached on 571-272-0926. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Allison M Ford
Examiner
Art Unit 1651

LEON B. LANKFORD, JR.
PRIMARY EXAMINER